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INSTITŪTS

Latvian State Institute of Wood Chemistry
Registration No. 90002128378
Address: Dzerbenes street 27, Riga LV-1006, Latvia
Phone: +371 67553063, E-mail: kki@kki.lv

State Research Programme "Research and Sustainable Use of Local Resources for the Development of Latvia 2023-2025"

Project No. VPP-ZM-VRIIILA-2024/2-0002 "Innovation in Forest Management and Value Chain for Latvia's Growth: New Forest Services, Products and Technologies (Forest4LV)"

WP1 "Forestry Data"

"Recommendations for increasing the vitality of pine forests"

Salaspils, 2025

SRP
State Research
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FOREST4LV

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Recommendations for the control of the six-toothed bark beetle *Ips acuminatus* Gyllenhal

Figure 1. *Ips acuminatus* Gyllenhal male (top) and female (bottom).

The six-toothed pine bark beetle *Ips acuminatus* Gyllenhal is a pine pest that is locally distributed in Latvia: currently the largest breeding areas are in Pierīga, Tērvete and Daugavpils. Typically, this pest causes the death of individual pine trees or groups of trees, but when multiplying massively, the six-toothed pine bark beetle can destroy entire stands.

Characteristics of the species: Small cylindrical beetles, on average 3.1 mm to 3.4 mm long, which are characterized by pronounced sexual dimorphism. In the upper part of the fang, there are three teeth on each side (six in total), of which the first from the top is the smallest, and the third is the largest, in males it is two-part (Figure 1). The most active flying time is July, but flying can begin already in early spring (>+18 ° C). The beetles are found in pine stands in dry forest types, often on the edges of the stand in the sunlit part. They develop in the crown part of the tree with thin bark.

In Latvian conditions, the six-toothed bark beetle usually develops one generation per year, but in recent years two generations per year have also been observed. The sex ratio characterizes the

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aggressiveness of the bark beetle population: the normal sex ratio is 1 male to 10 females, but in the final phase of reproduction this ratio can be 1:35 and even more than 1:200. It is recommended that managers of large forest areas and supervisory institutions (LVM, VMD, private forest owners) periodically assess the sex ratio in bark beetle populations in order to weigh the need for protection measures for pine stands.

Pheromone traps can be effectively used to monitor the species; by following changes in the sex ratio of the caught beetles, the vitality of the population can be assessed. Pheromone traps can be used in various areas where the spread of the species is suspected. It is necessary to develop a risk table that would provide an approximate threat forecast for forest stands, based on the number of beetles in monitoring traps.

In regions with high beetle prevalence, logging residues should be piled at the edges of the felling, avoiding piling them in the felling itself, thus attracting beetles to this area, rather than to growing trees. If infested logging residues are piled, the beetles develop without disturbance, using all the available wood for their development.

In stands with limited economic activity (e.g. nature parks, protected nature areas, urban forests), where it is not possible to remove infested trees, it is recommended to cut down pine trees, but to remove only the pine tops with the bark beetle colonized part of the trunk from the stand, while leaving the rest of the trunk in the forest. This practice has already been used in the Latvian State Forest Nature Park in Tērvete, where it was not possible to perform sanitary selective felling.

Proliferation is often detected after natural disturbances, especially after fires, however, there is no close relationship with the intensity of the fire and the area of the affected area. We recommend that after extensive fires, monitoring of the pine crown bark beetle in pine stands in the fire or its surroundings, using pheromone traps.

The last mass reproduction was observed in Stiklu bog after the 2018 fire and lasted 4 years. Pheromone traps can be effectively used to monitor the species, and the vitality of the population can be assessed by following changes in the sex ratio of the caught beetles.

We recommend that managers of large forest areas use remote sensing to detect bark beetle damage. The first changes in the color of the tree crown in images taken with a drone are visible as early as one and a half months after the bark beetles begin to fly. The browning of the needles begins with the departure of the young beetles, and complete dechroming of the crowns is observed after the departure of the young beetles. A large part of the young beetles remain to winter in the places of development - they do not leave the pine trunks. Thus, by detecting changes in time, it is possible to remove the infested trees from the stand together with all the beetles.

This is in contrast to the use of remote sensing for early detection of spruce bark beetles, where changes in the color of the spruce crown are only visible when the beetles have already left the tree.

Current experience shows that the removal of infested pine trees does not attract new six-toothed crown bark beetles. Therefore, the removal of newly infested pine trees is very important and does not endanger the remaining trees in the stand.

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The six-toothed crown bark beetle transmits several species of pathogenic and blue-rot fungi, such as *Sydowia polyspora, Diplodia sapinea, Ophiostoma minus, Leptographium piceaperdum*, which affect the quality of the infested wood.

The spread of blue rot in the trunk can be wider than the part of the crown infested by the beetles, therefore, in terms of wood quality, it is valuable to identify and remove infested trees from the stand as soon as possible, preventing the blue rot from developing in the more valuable part of the trunk.

Recommendations for limiting ungulate damage

In young pine stands of the most fertile forest types (Ln, Dm, Dms) up to 3 meters high, care should be taken at the beginning of the growing season, thus creating an opportunity for the undergrowth to regenerate during the season, which will provide an additional food base for ungulates (moose, red deer and roe deer) in the winter. Care of young stands carried out after the end of the growing season (in autumn and winter) increases the likelihood of damage to pine trees immediately after these care works (Figures 2 and 3). However, it should be borne in mind that the current regulatory enactments stipulate that from April 1 to June 30, care of pine and deciduous stands up to 10 years old and spruce stands up to 20 years old is prohibited in all forests, except for young stands, where the average height of coniferous trees does not exceed 0.7 meters, and the average height of deciduous trees is one meter.

When carrying out maintenance work in young pine stands up to 3 meters high, typical of less fertile and drier forest types (Sl, Mr), leave the willows, rowanberries and jackfruit already growing there in the undergrowth as much as possible, which will provide the basic food base for deer in the upcoming winter.

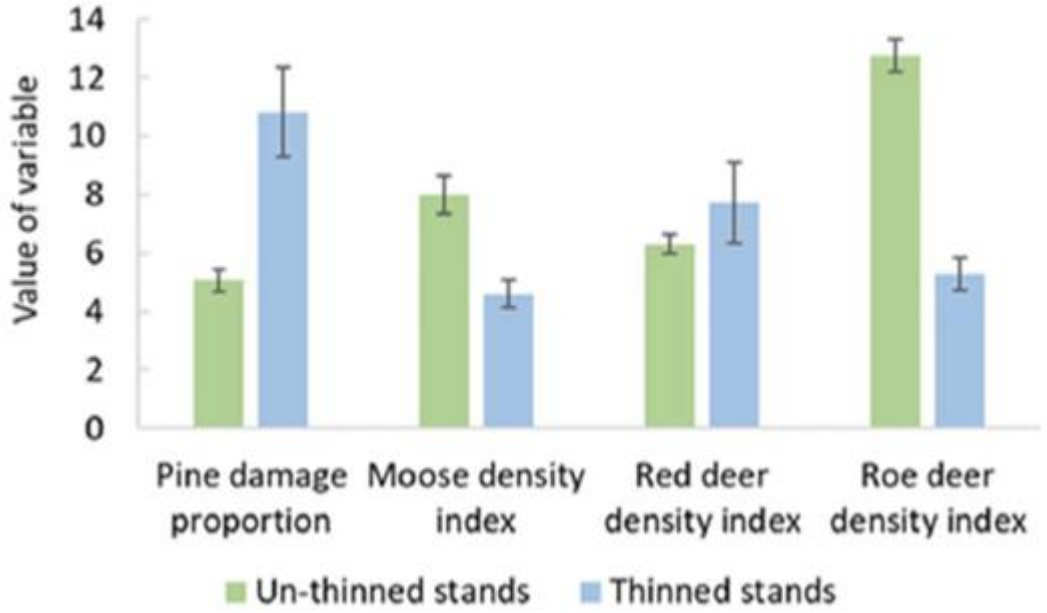

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Figure 2. Pine damage proportion, moose, red deer and roe deer density index values in thinned and un-thinned pine stands (Done et al., 2025).

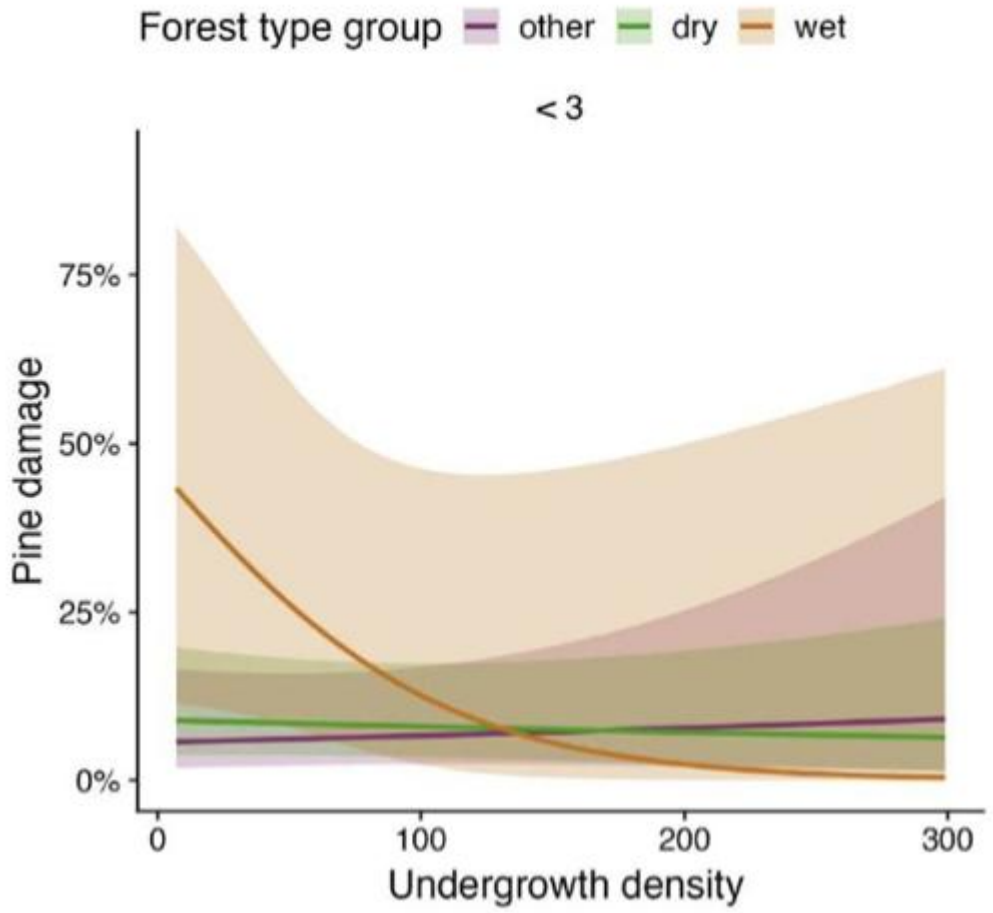

Figure 3. Proportion of damaged pine trees in young pine stands up to 3 m high depending on undergrowth density and forest type group ('dry' – stands with dry growing conditions (sils, sedges); 'wet' – stands with wetter, more fertile growing conditions (sedge, sedges, wet sedges, wet sedges); 'other' – other forest types) (Done et al., 2025).